

MATERIAL SAFETY DATA SHEET

PLUTONIUM METAL

SECTION 1: CHEMICAL PRODUCTS & COMPANY IDENTIFICATION

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CAS Number: 15117 -48-3

Substance: Plutonium Metal

Trade Names/Synonyms:

CRM126, CRM126 -A, Plutonium-239, Plutonium

Chemical Family:
Transuranic actinide

Radioactive

Creation Date: May 11, 1994 Revision Date: August 10, 2004

SECTION 2: COMPOSITION/INFORMATION ON INGREDIENTS

Component: Plutonium metal, primarily Plutonium -239
CAS Number: 15117 -48-3
Percentage: 99.9% Plutonium
Other Contaminants: Americium -241 and 0.04% Uranium (as decay products)

SECTION 3: HAZARD IDENTIFICATION

CERCLA RATINGS (SCALE 0 -3): HEALTH=U FIRE=3 REACTIVITY=2
PERSISTENCE=3

NFPA RATINGS (SCALE 0 -4): HEALTH=U FIRE=3 REACTIVITY=2

EMERGENCY OVERVIEW: Handle with caution, normally in a glove box type enclosure. Inhalation, ingestion, or absorption through skin abrasions may lead to heavy metal toxicity or radiation poisoning.

Fine particles are flammable and may catch fire if exposed to air. They may form flammable or explosive dust-air mixtures. Keep away from all ignition sources. Do not allow water to get in container. Avoid creation of dust.

INHALATION:

Short Term Exposure - May cause irritation. May cause kidney damage, yellowing of the skin and eyes, lack of appetite, nausea, vomiting, diarrhea, dehydration, blood in the urine, weakness, drowsiness, incoordination, twitching, sterility, blood disorders, convulsions and shock.

Long Term Effects - In addition to effects from short term exposure, anemia, cataracts, lung damage, liver damage and bone effects may occur.

SKIN CONTACT:

Short Term Exposure - No information available on significant adverse effects.

Long Term Effects - May cause effects as reported in other exposures.

EYE CONTACT:

Short Term Exposure - May cause irritation, redness and swelling. Additional effects may include sores and eye damage.

Long Term Effects - In addition to effects from short term exposure, cataracts may occur.

INGESTION:

Short Term Exposure - No information available on significant adverse effects.

Long Term Effects - Same effects as short term exposure.

CARCINOGEN STATUS:

OSHA

NTP: N

IARC: N

Note: Plutonium materials may cause cancer when internally deposited.

SECTION 4: FIRST AID MEASURES

INHALATION: Remove from exposure area to a restricted area with fresh air as quickly as possible. If breathing has stopped, perform artificial respiration by administering oxygen; mouth-to-mouth resuscitation should be avoided to prevent exposure to the person rendering first aid. Any evidence of serious contamination indicates that treatment must be instituted. (Inhalation of radioactive particles may indicate that other parts of the body were also contaminated, such as the digestive tract, skin and eyes.) If time permits, wipe the face with wet filter paper, force coughing and blowing of the nose. Get medical attention immediately. The victim may be contaminated with radioactive particles. Thorough decontamination should be started before the victim is moved to the medical area. Any personnel involved in rendering first aid must be monitored for radioactivity and thoroughly decontaminated if necessary (IAEA#3, Pg. 65).

SKIN CONTACT: Remove victim to a suitable area for decontamination as quickly as possible. Remove clothing and shoes immediately. Thoroughly wash the victim with soap and water, paying particular attention to the head, fingernails and palms of the hands. Upon completion of washing, monitor the victim for radioactivity. It is imperative that the skin should be decontaminated as quickly as possible. Minutes skin injuries greatly increase the danger of isotope penetration into the victim; shaving should not be attempted. If water and soap have been inadequate in removing the radioactive compound, decontaminating compounds consisting of surfactants and absorbent substances may be effective. Complexing reagents may also be of use. The use of organic solvents is to be avoided, as they may increase the solubility and absorption of the radioactive substance. Skin contamination with radioactivity may be an indication that other parts of the body have been exposed. Contaminated clothing must be stored in an airtight, chemically compatible container for later decontamination or disposal. The water used to wash the victim must be stored in an airtight, chemically compatible container for later disposal. Any personnel involved in rendering first aid to the victim must be monitored for radioactivity and decontaminated if necessary (IAEA#47, Pg. 9; IAEA#3, Pg. 62).

EYE CONTACT: Remove victim to a restricted area for decontamination. Thoroughly wash eyes with large amounts of water, occasionally lifting the upper and lower lids (approximately 15 minutes). Following the water treatment, provide an isotonic solution. Do not use eye baths, rather provide a continuous and copious supply of fluid. Monitor the victim for radioactivity. If activity is present, rewash the eyes, and remonitor until little or no radioactivity is present. Get medical attention immediately. Any water used to wash the victim's eyes must be stored in an airtight, chemically compatible container for later disposal. Any other articles that are used to decontaminate the victim must also be stored in similar containers for later decontamination or disposal. Any personnel involved in

rendering first aid to the victim must be monitored for radioactivity and decontaminated if necessary (IAEA #3, Pg. 65; IAEA #47, Pg. 35).

INGESTION: In the case of ingestion of radioactive substances, the mouth should be rinsed out immediately after the accident, care being taken not to swallow the water used for this purpose. Vomiting should be induced either mechanically, or with syrup of ipecac. Do not induce vomiting in an unconscious person. Lavage may be useful. Care should be taken to avoid aspiration. The vomitus and lavage fluids should be saved for examination and monitoring. Get medical attention immediately. The gastric fluids and fluids used for lavage must be stored in airtight, chemically compatible containers for later disposal. The victim must be monitored for radioactivity and decontaminated, if necessary, before being transported to a medical facility. Any personnel involved in rendering first aid to the victim must be monitored for radioactivity and decontaminated if necessary (IAEA #47, Pg. 9; IAEA #3, Pp. 59, 66).

NOT TO PHYSICIAN:

TREATMENT - The following treatment has been recommended. However, the decision as to whether the severity of poisoning requires administration of any chelating agent and actual dose required should be made by qualified medical personnel.

FOR PLUTONIUM INGESTION/INJECTION: Give 0.5 gram of the calcium salt of diethylenetriaminepentaacetic acid (DTPA) diluted in 250 mL of physiological saline given by slow intravenous injection (IAEA Safety Series #47).

For inhalation contamination: Prepare a Ca-DTPA aerosol immediately using a Ca-DTPA ampule in a conventional generator or, preferably, a capsule of micronized Ca-DTPA in a generator producing an aerosol of suitable particle size, and always inject 0.5 g of Ca-DTPA intravenously; pulmonary lavage should be considered by qualified medical personnel (IAEA Safety Series #47).

For contaminated wound: Inject Ca-DTPA intravenously and wash the wound locally with a concentrated Ca-DTPA solution (one ampule); possible surgical removal of the plutonium in the wound should only be considered by qualified medical personnel (IAEA Safety Series #47).

SECTION 5: FIRE FIGHTING MEASURES

FIRE AND EXPLOSION HAZARD: Negligible fire hazard in bulk form; however, dust, powder, or fumes are flammable or explosive when exposed to heat or flames.

EXTINGUISHING MEDIA: Small fires - *Metal-X* (Class D) fire extinguisher. See also: 2000 *Emergency Response Guidebook*, (ERG 2000), developed jointly by Transport Canada

(TC), the U.S. Department of Transportation (DOT) and the Secretariat of Transportation and Communications of Mexico (SCT).

FIREFIGHTING: Do not move damaged containers; move undamaged containers out of fire zone. (2000 *Emergency Response Guidebook*, ERG2000).

Contact the local, State, or Department of Energy radiological response team. Use suitable agent for surrounding fire. Cool containers with flooding amounts of water, apply from as far a distance as possible. Avoid contamination of water sources and sewers. Avoid breathing dusts or vapors, keep upwind. Keep unnecessary people out of area until declared safe by radiological response team.

SECTION 6: ACCIDENTAL RELEASE MEASURES

OCCUPATIONAL SPILL: Do not touch damaged containers or spilled material. For large spills, dike far ahead of spill for later disposal. For dry spills, cover with plastic sheet or tarp to minimize spreading. Keep unnecessary people at least 150 feet upwind of spill. Isolate hazard area and deny entry. Limit entry to shortest time possible. Clean-up should be performed only by qualified radiation worker(s).

SECTION 7: HANDLING AND STORAGE

Handle under proper radiologically controlled conditions at all times. Consult the Health Physicist at your facility for specific, appropriate procedures.

Observe all Federal, State, and local regulations when storing this substance.

Store in accordance with 10 CFR 20.

Store in designated radioactive materials area.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

EXPOSURE LIMITS: Occupational exposure to radioactive substances must adhere to standards established by the Occupational Safety and Health Administration, 29 CFR 1910.96, and/or the Nuclear Regulatory Commission, 10 CFR Part 20.

VENTILATION: At a minimum, provide process enclosure ventilation. Depending upon work activities, a more stringent ventilation system may be necessary to comply with exposure limits set forth by law (10 CFR 20.103). In particular, a High Efficiency Particulate Air (HEPA) filtration system may be required for handling and storing this material.

One method of controlling external radiation exposure is to provide adequate shielding. The absorbing material used and the thickness required to attenuate the radiation to acceptable levels depends on the type of radiation, its energy, the flux and the dimension of the source.

ALPHA PARTICLES: For the energy range of alpha particles usually encountered, a fraction of a millimeter of any ordinary material is sufficient for absorbance. Thin rubber, acrylic, stout paper, or cardboard will suffice.

BETA PARTICLES: Beta particles are more penetrating than alpha, and require more shielding. Materials composed mostly of elements of low atomic number such as acrylic, aluminum and thick rubber are most appropriate for the absorption of beta particles. For example, 1/4 inch of acrylic will absorb all beta particles up to 1 MeV.

GAMMA RAYS: The most suitable materials for shielding gamma radiation are lead and iron. The thickness required will depend on whether the source is producing narrow or broad beam radiation. Primary and secondary protective barriers may be required to block all radiation.

EYE PROTECTION: Employee must wear appropriate eye protection that will not allow the introduction of particles into the eyes. Contact lenses should not be worn.

Clothing, glove and eye protection equipment will provide protection against alpha particles, and some protection against beta particles, depending on thickness, but will not shield gamma radiation.

CLOTHING: Overgarments, including head coverings and foot covering, should be worn by any employee engaged in handling radioactive substances. These garments are also recommended even if the employee is working with a "glovebox" containment system. Certain clothing fibers may be useful in dosimetry so clothing should be kept.

In the event of an accident, large scale release or a large scale clean-up, full protective clothing will be necessary.

GLOVES: Employee must wear appropriate protective gloves to prevent contact with this substance. Used gloves may present a radioactive contamination hazard and should be disposed of as radioactive waste.

RESPIRATOR: Respirators should provide protection for the respiratory tract against inhalation of most of the radioactive particles encountered in the workplace. Respirators will not offer protection against beta and gamma radiation, but will block alpha particles. (For additional information see: 10 CFR 20.103 Appendix A.) Respiratory equipment must be jointly certified by NIOSH/MSHA. The following respiratory protection is recommended. Lower levels of protection may be appropriate depending on containment systems. Consult a qualified health physicist for more information.

General conditions: Type 'C' supplied -air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet or hood operated in continuous -flow mode.

Self-contained breathing apparatus with a full facepiece operated in pressure -demand or other positive pressure mode.

For firefighting and other immediately dangerous to life or health conditions:

Self-contained breathing apparatus with full facepiece operated in pressure -demand or other positive pressure mode.

Supplied-air respirator with full facepiece and operated in pressure -demand or other positive pressure mode in combination with an auxiliary self -contained breathing apparatus operated in pressure -demand or other positive pressure mode.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

DESCRIPTION: grayish white, dense silvery, radioactive solid that is strongly electropositive. It is ductile and malleable and small particles may ignite spontaneously in air.

Molecular weight: Approximately 239 (varies with isotopic abundances)

Molecular formula: Pu

Melting point: 1186 °F (641 °C) (alpha form)

Boiling point: 5850 °F (3232 °C) (alpha form)

Specific gravity: 19.84 (alpha form)

Water solubility: insoluble

Solvent solubility: Soluble in hydrochloric acid; insoluble in nitric acid, concentrated sulfuric acid

Specific activity - The specific activities of the various plutonium isotopes (and ²⁴¹Am) are as follows:

$$^{238}\text{Pu} = 6.3 \times 10^5 \text{ MBq/g (17 Ci/g)}$$

$$^{239}\text{Pu} = 2.3 \times 10^3 \text{ MBq/g (6.2} \times 10^{-2} \text{ Ci/g)}$$

$$^{240}\text{Pu} = 8.5 \times 10^3 \text{ MBq/g (2.3} \times 10^{-1} \text{ Ci/g)}$$

$$^{241}\text{Pu} = 4.1 \times 10^6 \text{ MBq/g (1.1} \times 10^2 \text{ Ci/g)}$$

$$^{242}\text{Pu} = 1.4 \times 10^2 \text{ MBq/g (3.9} \times 10^{-3} \text{ Ci/g)}$$

$$^{241}\text{Am}=1.2 \times 10^{-5} \text{ MBq/g (3.2 Ci/g)}$$

Half Life - The half-lives of the various plutonium isotopes are as follows:

$$^{238}\text{Pu}=87.74\text{y}; \quad ^{239}\text{Pu}=2.41 \times 10^4\text{y}; \quad ^{240}\text{Pu}=6.56 \times 10^3\text{y}; \quad ^{241}\text{Pu}=14.29\text{y};$$

$$^{242}\text{Pu}=3.73 \times 10^5\text{y}.$$

Critical Mass: >5.0 kg for Pu metal;
>500 g for Pu in any form

SECTION 10: STABILITY AND REACTIVITY

REACTIVITY: May form pyrophoric products on exposure to air and moisture which may present a fire hazard with subsequent spread of radioactive material.

CONDITIONS TO AVOID: Radiation hazard, do not allow material to spread or contaminate water sources.

Care must be taken in the handling of plutonium to avoid unintentional formation of a critical mass (see SECTION 9, above). Plutonium in liquid solutions poses a greater criticality hazard than solid plutonium.

INCOMPATIBILITIES:

Carbon Tetrachloride: May ignite or explode.

POLYMERIZATION: Hazardous polymerization has not been reported to occur under normal temperature and pressures.

SECTION 11: TOXICOLOGY INFORMATION

PLUTONIUM-239:

CARCINOGEN STATUS: None. However, exposure to ionizing radiation may cause cancer and plutonium may be carcinogenic when internally deposited.

ACUTE TOXICITY LEVEL: No data available.

TARGET EFFECTS: Plutonium in the body most often accumulates in the lungs, lymph nodes, liver and skeleton. Lesser, yet significant, quantities may also be found in the spleen, gonads, and thyroid. The biological half-lives have been reported to be 40 years in the liver and 100 years in the bone. Radioactive materials present the greatest hazard to those parts of the body in which they are most concentrated.

AT INCREASED RISK FOR EXPOSURE: Persons with chronic obstructive lung disease cannot clear inhaled materials, resulting in above average doses to the tissues of the lung and bronchi. Persons with iron deficiency anemia may take up plutonium more readily than the general population, as biologically, plutonium acts in a similar fashion to iron.

ADDITIONAL DATA: Plutonium -239 is an emitter of alpha particles and some gamma rays in the range of 100 - 600 keV. Exposure to radioactive plutonium may result in significant whole -body irradiation.

HEALTH EFFECTS: INHALATION

ACUTE EXPOSURE - When inhaled, plutonium is retained in the lung with an effective half-life that varies from hundreds of days for plutonium oxides to tens of days for more soluble forms. Plutonium solubilized within the lungs is translocated to the liver and skeleton where it is retained.

Following an inhalation of an aerosol containing plutonium, the pattern of its deposition and clearance from the respiratory tract and the fraction eliminated from the body, as well as the fraction deposited in the target organ, depends on a variety of factors. These factors include the size, shape and density of the particles inhaled, as well as the chemical form. Large insoluble particles may remain at or near the site of deposition, and cause local damage. Soluble compounds may rapidly enter the bloodstream. The damage depends on how quickly they are eliminated, and the susceptibility of the tissue in which they are stored. Heavier inhaled particles will be brought up to the throat by ciliary action, and may then be swallowed. Lighter inhaled particles may become lodged in the alveolar air sacs and remain there for some time. Alpha radiation will kill cells immediately adjacent to the source of contact. Animals exposed to single high doses of soluble plutonium compounds died from radiation pneumonitis characterized by edema, fibrosis and respiratory damage. Death occurred in 1 -3 years. The livers of exposed animals were congested, pigmented and granular.

CHRONIC EXPOSURE - No clinical illness has been attributed to long -term internally deposited plutonium as a result of occupational exposure, and a mortality study of 224 plutonium workers has shown no excess deaths from any cause. One study with a small number of subjects showed a statistically significant increase in multiple myelomas. Long term exposure of dogs to plutonium oxide resulted in radiation pneumonitis, pulmonary fibrosis, and death due to primary neoplasia. The effects of chronic exposure by internally deposited alpha active material is dependent upon the amount, isotopic distribution, and tissue. If large amounts become internally deposited, lung cancer, sterility, anemia, leukemia, or bone cancer may occur.

SKIN CONTACT:

ACUTE EXPOSURE - Alpha radiation is not usually an external hazard and penetration of soluble plutonium compounds through healthy skin has never been reported. Contamination may occur through broken skin. The lens of the eye may also be affected if eye contact occurs, and local damage may occur at the site of a wound. In extreme cases, absorption or penetration through damaged skin may result in radiation sickness.

CHRONIC EXPOSURE - No specific data are available. However, exposure to radiation may result in delayed effects. The delayed effects of radiation may be due either to a single large overexposure or continuing low-level overexposure. Delayed effects of exposure may include cancer, genetic effects, life span shortening and cataracts. At least one researcher has postulated that chronic exposure to low levels of radiation may result in life span **lengthening**.

Cancer is observed most frequently in the hematopoietic (blood forming) system, as well as the thyroid, bone and skin. Leukemia is among the most likely forms of malignancy. Lung cancer may also occur due to insoluble radioactive materials residing in the lungs (see inhalation section above). Genetic effects may range from point mutations to severe chromosome damage such as strand breakage, translocations, and deletions (occurring in cases of extremely large doses). Theoretically, if the germ cells have been affected, the effects of the mutation may not become apparent until following generations. In humans there has never been a confirmed genetic effect caused by radiation exposure.

EYE CONTACT:

ACUTE EXPOSURE - No specific data available. Repeated or prolonged exposure to alpha radiation may result in cataract formation. Of the well-documented late effects of radiation on man, leukemia and cataracts have been observed at doses lower than those producing skin scarring and cancer or bone tumors. The lens of the eye is considered to be a critical organ for exposure to radiation. Because alpha particles do not travel far in air, long term exposure of the eye to alpha radiation will only occur under conditions of extremely poor work practice.

CHRONIC EXPOSURE - No specific data available. Repeated or prolonged exposure to alpha radiation may result in cataract formation. See acute exposure.

INGESTION:

ACUTE EXPOSURE - Intestinal absorption is virtually zero; 0.003% for soluble compounds such as plutonium sulfate.

CHRONIC EXPOSURE - No specific data available.

SECTION 12: ECOLOGICAL INFORMATION

Environmental Impact Rating (0 - 4): No data available

Acute Aquatic Toxicity: No data available

Degradability: No data available

Log Bioconcentration Factor (BCF): No data available

Log Octanol/water partition coefficient: No data available

SECTION 13: DISPOSAL INFORMATION

Observe all Federal, State and local Regulations when disposing of this substance.

Disposal must be in accordance with 10 CFR 20 and 60.

SECTION 14: TRANSPORTATION INFORMATION

U.S. Department of Transportation Hazard Classification, 49 CFR 173 Subpart I - Class 7
- (Radioactive) Materials

U.S. Department of Transportation Labeling Requirements 49 CFR 172.101 and 49 CFR 172 Subpart E - Labeling and 172.402; Additional Labeling requirements for subsidiary hazards.

U.S. Department of Transportation Shipping Name - ID Number, Hazard Class or Division, 49 CFR 172.101

U.S. Department of Transportation Packaging Authorizations:

Exceptions: 49 CFR 173.421, and 173.453

Specific requirements: 49 CFR 173.455

Non-Bulk Packaging: 49 CFR 173.415, or 173.417

Bulk Packaging: None

SECTION 15: REGULATORY INFORMATION

TSCA STATUS:	N
CERCLA SECTION 103(40CFR302.4):	N
SARA SECTION 302(40CFR355.30):	N
SARA SECTION 304(40CFR355.40):	N
SARA SECTION 313(40CFR372.65):	N
OSHA PROCESS SAFETY (29CFR 1910.119):	N
CALIFORNIA PROPOSITION 65:	N

SARA HAZARD CATEGORIES, SARA SECTIONS 311/312(40CFR370.21)

ACUTE HAZARD:	N
CHRONIC HAZARD:	N
FIRE HAZARD:	N
REACTIVITY HAZARD:	N
SUDDEN RELEASE HAZARD:	N

SECTION 16: OTHER INFORMATION

This material is prepared for use as a standard or in interlaboratory comparison programs at analytical laboratories that routinely handle uranium and/or plutonium. The New Brunswick Laboratory (NBL) assumes that recipients of this material have developed internal safety procedures to guard against accidental exposure to radioactive and toxic materials, contamination of the laboratory environment, or criticality. NBL further expects that personnel who handle radioactive materials have been thoroughly trained in the safety procedures developed by and for their Laboratory.

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